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JP 007096259 A JP 002006886 A US 5711821 A
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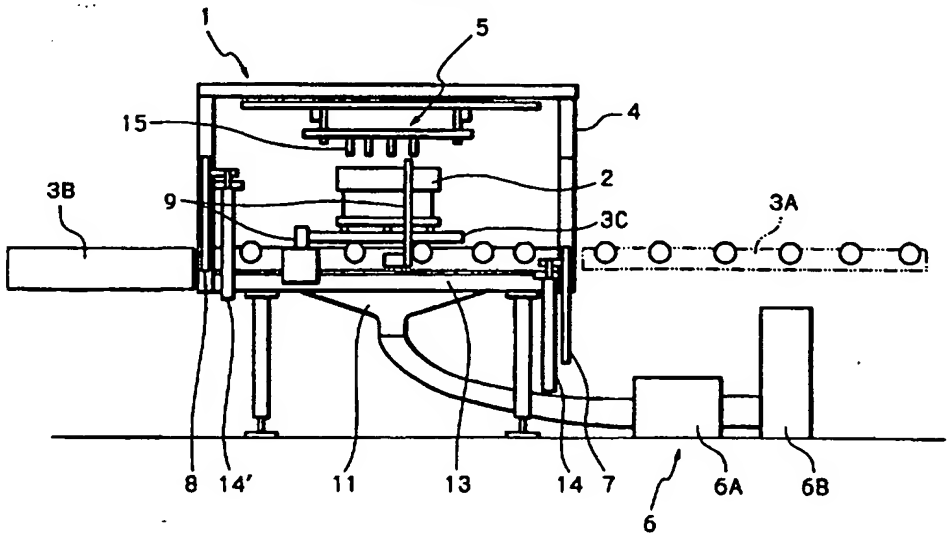
(54) Abstract Title
Device for removing dust by blowing and sucking

(57) A dust removing device of the present invention includes air jetting means 5 for jetting air intermittently from a plurality of nozzles (15) toward a desired assembly. With the air jetting means, the device is capable of causing dust blown away from the assembly to be efficiently carried by an air stream generated by sucking means (6A). The intermittent air jets easily remove even dust having particle sizes of less than 20 μm.

Fig. 3



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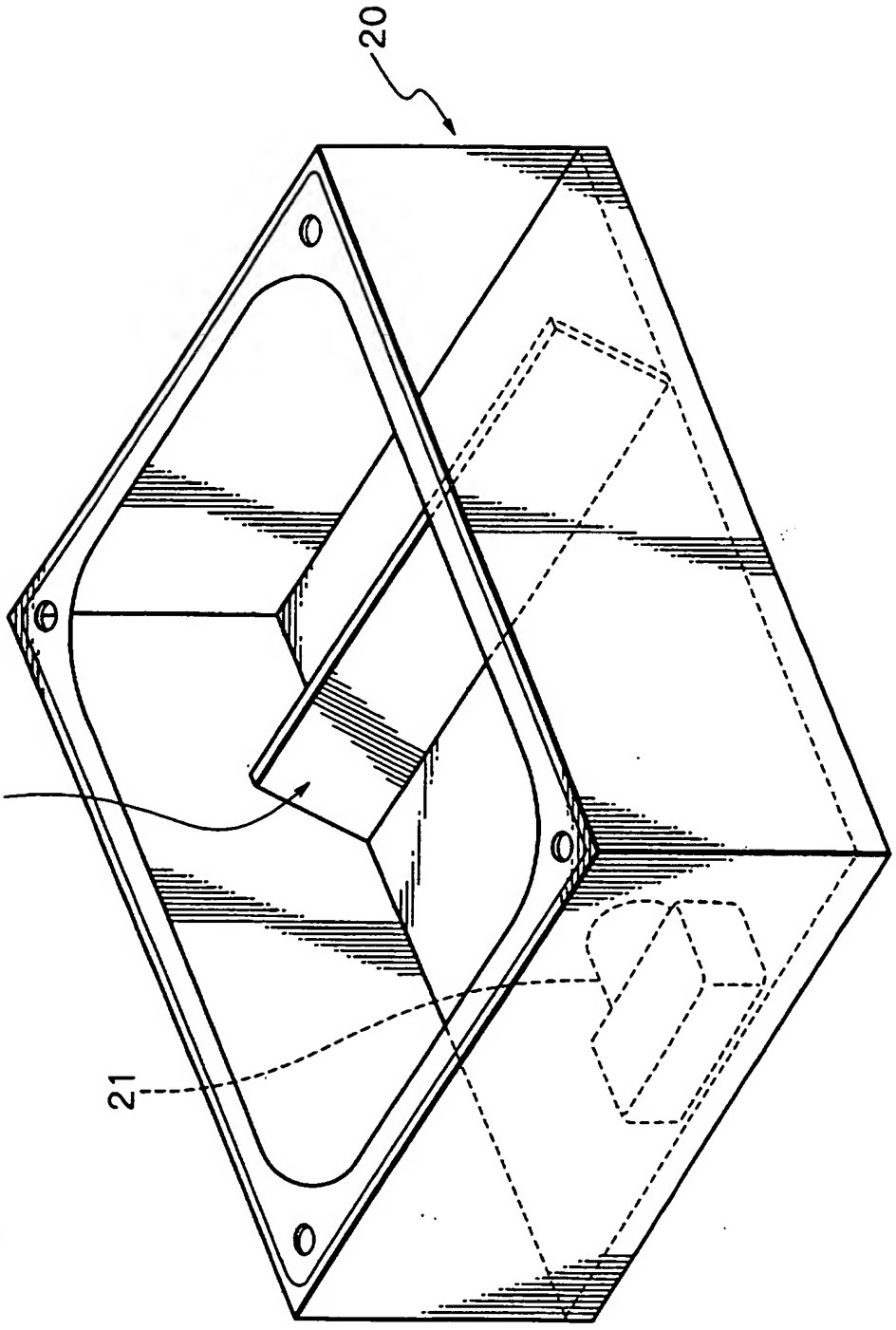
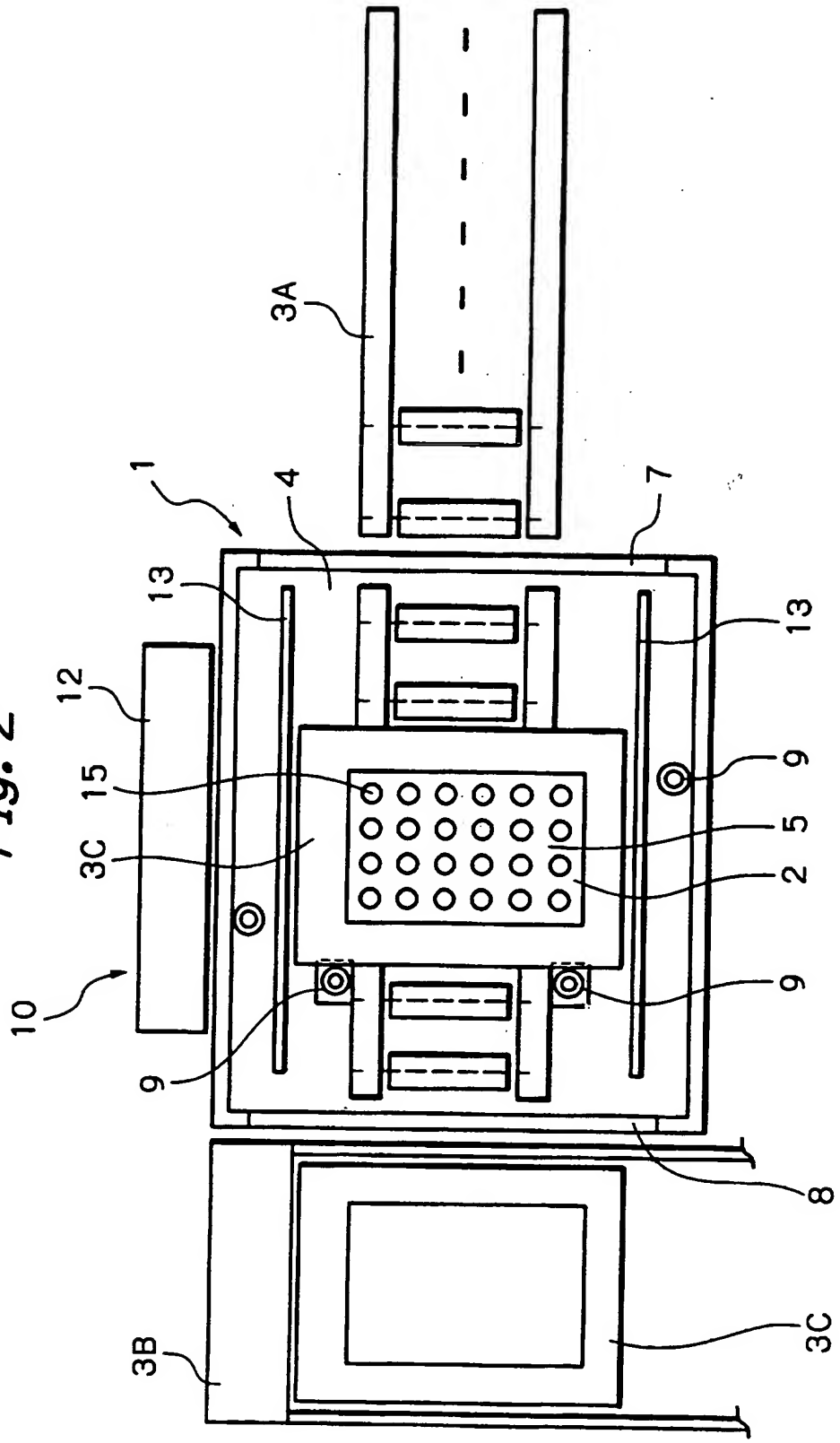


Fig. 1

Fig. 2



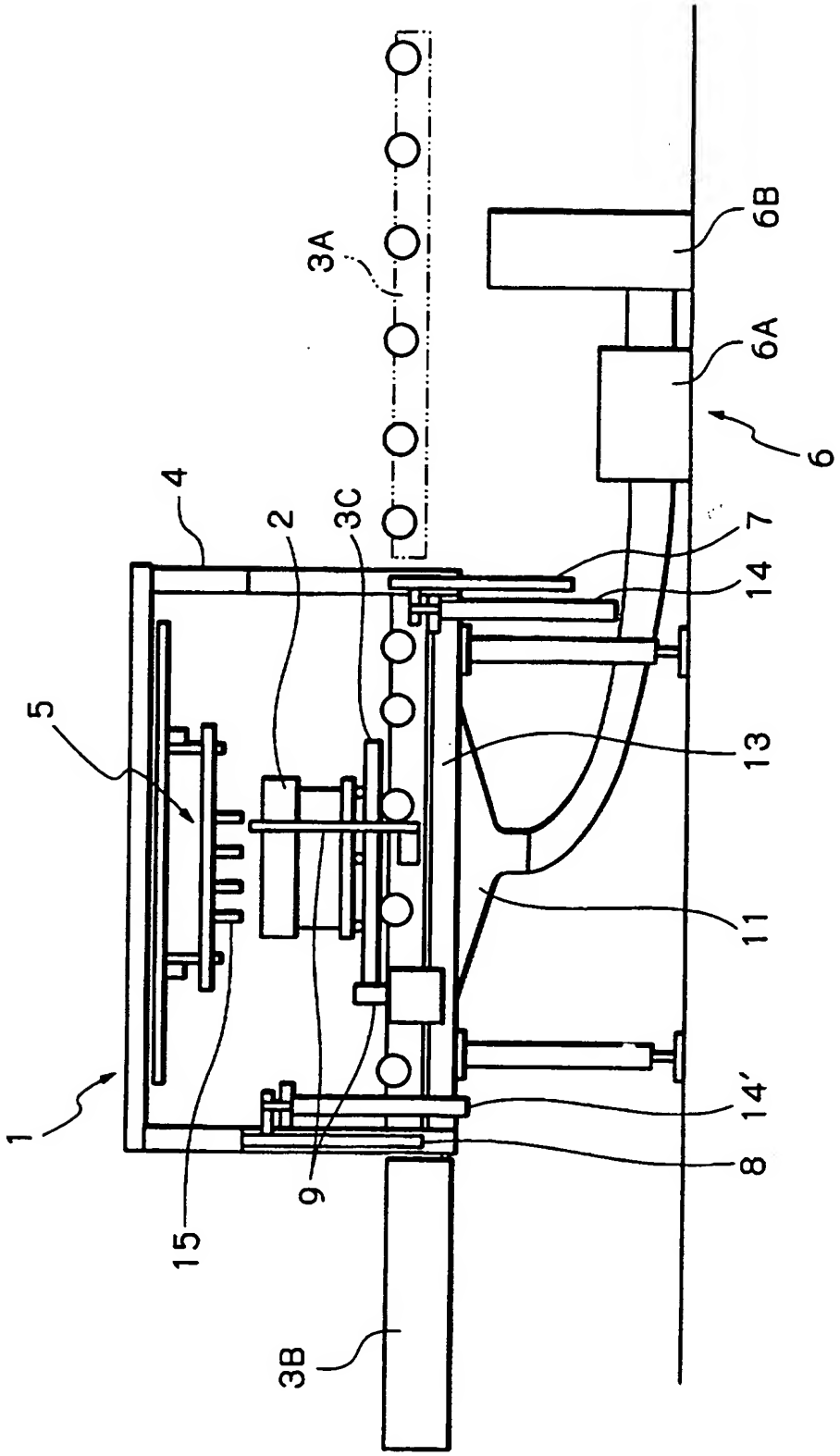


Fig. 3

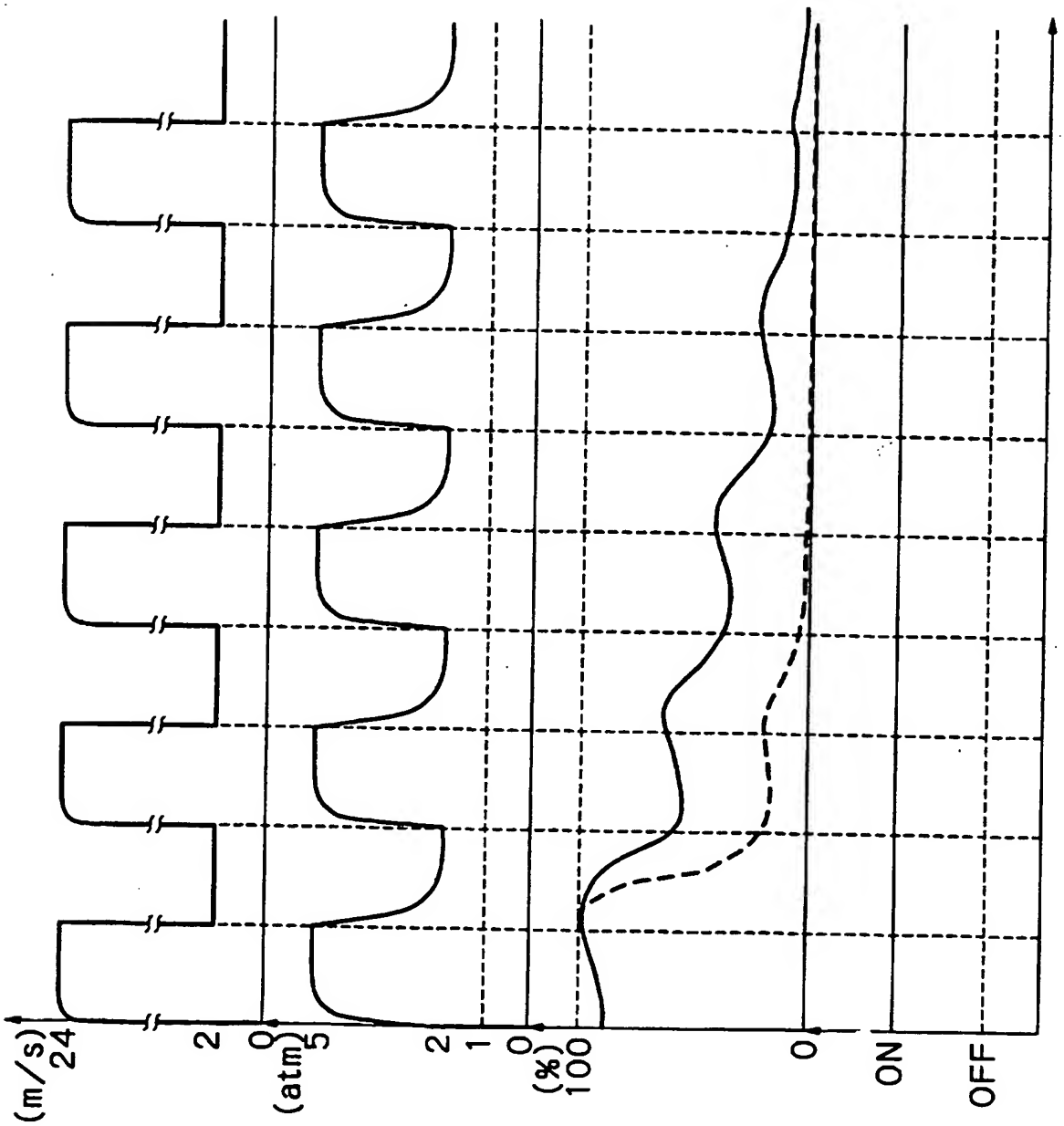


Fig. 4A

Fig. 4B

Fig. 4C

Fig. 4D

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DEVICE FOR REMOVING DUST DEPOSITED ON AN ASSEMBLY

The present invention relates to a device for removing dust deposited on an assembly and more particularly to a device capable of efficiently removing dust having relatively small particle sizes from a precision apparatus or similar assembly.

It is a common practice with a precision apparatus or similar assembly to remove dust having particle sizes of larger than 20 μm inclusive on the production and assembly line in order to enhance the reliability and performance of a product. For the removal of the dust, air under preselected pressure has customarily been continuously jetted toward the surfaces of the assembly for blowing off the dust. At the same time, sucking means sucks the dust blown away from the surfaces of the assembly.

To further enhance the reliability and performance of products, there is an increasing demand for the removal of even dust having particle sizes of less than 20 μm. However, the problem with the above conventional continuous air jet scheme is that a stream of air produced by the sucking means cannot easily carry away dust having particle sizes of less than 20 μm and blown off by the air jet. Specifically, such dust is born by a swirl of air (turbulence)

produced by the air jet and floats above the assembly and again falls toward the assembly.

It is therefore an aim of the present invention to provide a device capable of efficiently removing even dust having small particle sizes of less than 20 μm deposited on an assembly.

A device for removing dust deposited on an assembly of the present invention includes an air jetting section for jetting air under preselected pressure intermittently from a plurality of air nozzles toward the assembly to thereby blow away the dust. A sucking section sucks the dust blown away by the air jetting section.

The above and other features and advantages of the present invention will become more apparent from the following detailed description taken with the accompanying drawings in which:

FIG. 1 is a perspective view showing a specific assembly to which the present invention is applicable;

FIG. 2 is a plan view showing a dust removing device embodying the present invention;

FIG. 3 is a side elevation of the device shown in FIG. 2; and

FIGS. 4A, 4B, 4C and 4D are timing charts showing a relation between intermittent air jets unique to the illustrative embodiment, pressure in a dust removing chamber, and the ratio of dust floating

in the chamber.

To better understand the present invention, brief reference will be made to a specific assembly from which dust having particle sizes of above 20 μm inclusive should be removed, shown in FIG. 1. The specific assembly is implemented as a scanner forming a part of a copier by way of example. As shown, the scanner, generally 20, includes a lens unit 21 and a movable mirror 22. Assume that dust is deposited on the movable mirror 22. Then, when the scanner 20 reads a document image, the dust on the mirror 22 having particle sizes of larger than 20 μm inclusive are focused on a one-dimensional CCD (Charge Coupled Device) line image sensor included in the lens unit 21. As a result, stripes appear in the resulting copy and lower image quality. It has been customary to remove dust deposited on the mirror 22 and lens unit 21 as far as possible before mounting a glass platen, not shown, to the scanner 20. For the removal of the dust, air under preselected pressure is continuously jetted toward the surface of the mirror 22 and that of an object lens included in the lens unit 21. At the same time, sucking means sucks the dust blown away from the mirror 22 and object lens.

However, the above conventional scheme relaying on the continuous air jet has the following problem left unsolved. A stream of air produced by the sucking means cannot easily carry away dust having particle sizes of less than 20 μm and blown away by the air

jet. Specifically, such dust is born by a swirl of air (turbulence) produced by the air jet and floats above the scanner 20 and again falls toward the scanner 20, as discussed earlier.

Referring to FIGS. 2 and 3, a dust removing device embodying the present invention and capable of solving the above problem will be described. As shown, the dust removing device includes a device body 1. An assembly 2 put together by a preselected sequence of steps is loaded on a pallet 3C. A conveyor 3A conveys the pallet 3C with the assembly 2 into the device body 1.

The device body 1 includes a dust removing chamber 4, air jetting means 5 for jetting air under preselected pressure, and sucking means 6 for sucking dust blown away by air in the chamber 4. The dust removing chamber 4 is provided with an inlet door 7, an outlet door 8, a sensor 9, air sucking means 10, and a suction duct 11 communicated to sucking means 6. Cylinders 14 and 14 selectively open or close the inlet door 7 and outlet door 8, respectively.

As shown in FIG. 2, the air sucking means 10 is positioned at one side of the dust removing chamber 4 and includes an electrostatic filter 12. The air sucking means 10 sucks air from the outside with a suction fan via an air inlet, although not shown specifically. The electrostatic filter 12 filters out dust being carried by the outside air. The outside air maintains the inside of the chamber 4 at a slightly higher pressure than the outside of the chamber 4, i.e., at a positive pressure. It is therefore possible to prevent dust from entering the chamber 4 without resorting to an air-tight structure.

As shown in FIG. 3, the suction duct 11 is connected to the bottom of the dust removing chamber 4 at one end and to the sucking means 6 at the other end. The suction duct 11 has its sectional area sequentially reduced downward, as illustrated. The sucking means 6 includes a suction motor 6A and an electrostatic filter 6B. A rectifying plate 13 adjoins the suction duct 11 in order to obviate the turbulence of air at the time of suction.

The air sucking means 10 and sucking means 6 respectively suck air and discharges it, generating a constant air stream in the dust removing chamber 4. The air stream carries dust floating in the chamber 4 and thereby removes it. In the illustrative embodiment, the flow rate of the air stream is selected to be 1.2 m/s to 1.8 m/s.

The sensor 9 disposed in the dust removing chamber 4 is responsive to the assembly 2 conveyed into the dust removing chamber 4, i.e., determines whether or not the assembly 2 has been brought to a stop at a preselected position in the chamber 4. The inlet door 7 is closed in response to the output of the sensor 9 representative of the above position of the assembly 2.

The air jetting means 5 is disposed in the upper portion of the dust removing chamber 4 and implemented by a plurality of air nozzles 15. In the illustrative embodiment, the air jetting means 5 has twenty-four air nozzles 15 arranged in six parallel arrays. Each air nozzle 15 jets air under a pressure higher than the positive pressure toward the assembly 2. The air jetting means 5 includes an ionizer, not shown, for ionizing air being jetted from the air nozzles

15 to positive and negative polarities. This is successful to neutralize dust and therefore to reduce the adhesion of the dust to the surfaces of the assembly 2, e.g., the surface of the movable mirror 22 and that of the object lens of the lens unit 21 (FIG. 1). In the illustrative embodiment, the air nozzles 15 jet ionized air under the above pressure toward the assembly 2 intermittently at the maximum flow rate of 24 m/s. During intervals between jets, the air nozzles 15 send air at a flow rate of about 2 m/s in order to maintain the positive pressure in the dust removing chamber 4 in cooperation with the air sucking means 10.

Air jetted toward the assembly 2 at the pressure higher than the positive pressure blows away dust deposited on the surfaces of the assembly 2. Because this air has been ionized, it electrically neutralizes the dust and promotes the separation of the dust from the surfaces of the assembly. The dust blown away in the dust removing chamber 4 and having relatively large particle sizes, i.e., above 20 μm inclusive is easily carried downward by the air stream generated by the sucking means 6 despite the swirl of air ascribable to the air jets. This part of the dust is conveyed by the air stream to the sucking means 6 via the suction duct 11 and removed thereby.

On the other hand, much of dust having particle sizes of less than 20 μm floats due to the swirl of air ascribable to the air jets and does not easily fall. However, as soon as the air ejecting means 5 interrupts its ejection, i.e., as soon as the swirl of air disappears, the air stream continuously generated by the air sucking means 10 and

sucking means 6 carries the above dust to the sucking means 6 via the suction duct 11. Thereafter, the sucking means 5 again jets air toward the assembly 2.

Dust-containing air sucked via the suction duct 11 is filtered by the electrostatic filter 6B and then discharged to the outside as clean air. After the removal of dust from the assembly 2, the outlet door 8 is opened. A conveyor 3B conveys the assembly 2 cleaned by the above procedure to the next assembly stage.

FIGS. 4A is a timing chart showing how the air jetting means 5 jets air intermittently while FIG. 4B shows how the pressure in the dust removing chamber 4 varies in accordance with the air jets. FIG. 4C shows the amount (ratio) of dust floating in the chamber 4 in relation to the air jets. The sucking means 6 continuously sucks air, as shown in FIG. 4D. As shown, the air jets occurring intermittently at the pressure higher than the positive pressure cause the pressure in the chamber 4 to repeatedly vary between 5 atm. and 2 atm. More specifically, the pressure in the chamber 4 begins to rise slightly later than the beginning of each air jet and sharply falls when the air jet is interrupted. Air jetted toward the assembly 2 under the preselected pressure blows away the dust deposited on the assembly 2. Assuming that the number of dust particles blown away by the first air jet and floating in the chamber 4 is 100 %, FIG. 4C shows the variation of the amount of floating dust in relation to the repeated air jet. In FIG. 4C, a solid curve and a dashed curve are respectively representative of the ratio of dust having particle sizes of less than

20 μm (e.g. 10 μm) and the ratio of dust having particle sizes of larger than 20 μm inclusive.

As FIG. 4C indicates, when air is jetted toward the surfaces of the assembly 2 under the pressure higher than the positive pressure, it blows away dust deposited on the above surfaces with the result that the ratio of floating dust slightly increases. However, when the air jet is interrupted, the ratio of floating dust decreases due to the suction of the sucking means 6. Just after the jet of air, some period of time is necessary for the ratio of floating dust to decrease because the swirl of air occurs. The next jet of air again blows away the dust fallen onto the surfaces of the assembly 2, causing the ratio of floating dust to rise again. At this time, however, the increase in the ratio of floating dust is smaller than the previous increase because the sucking means 6 has already sucked a substantial amount of dust during the first jet of air. In this manner, as air is repeatedly jetted under the pressure higher than the positive pressure, the ratio of floating air gradually decreases until the dust has been fully removed from the surfaces of the assembly 2.

As for the ratio of floating dust, dust having particle sizes of larger than 20 μm inclusive is successfully reduced by a far smaller number of times of air jet than the dust having particle sizes of less than 20 μm. This is because dust with relatively large particle sizes is easier to fall and therefore carried more easily than the air stream generated by the sucking means 6, i.e., the former is sucked more efficiently than the latter.

In summary, in accordance with the present invention, a dust removing device includes air jetting means for jetting air intermittently toward a desired assembly. With the air jetting means, the device is capable of causing dust blown away from the assembly to be efficiently carried by an air stream generated by sucking means. The intermittent air jets easily remove even dust having particle sizes of less than 20 μm, compared to the conventional continuous air jet scheme.

Various modifications will become possible for those skilled in the art after receiving the teachings of the present disclosure without departing from the scope thereof. For example, while the sucking means 6 has been shown and described as continuously sucking air from the chamber 4 even during intervals between consecutive air jets, it may suck it only during the intervals.

CLAIMS

1. A device for removing dust deposited on an assembly, the device comprising:

air jetting means for jetting air under pressure from a plurality of air nozzles toward the assembly to thereby blow away the dust, said air jetting means being adapted to jet air at a pressure which varies with time; and

sucking means for sucking the dust blown away by said air jetting means.

2. A device according to claim 1, wherein said air jetting means is adapted to jet air in alternating periods at high and low pressures.

3. A device according to claim 2, wherein the flow rate of air jetted by the jetting means is at least 5 and preferably 10 times greater during high pressure periods than during low pressure periods.

4. A device according to claim 2 or 3, wherein said sucking means includes a suction opening positioned below the assembly for sucking the dust floating during an interval between consecutive air jets from said air jetting means.

5. A device according to claim 4, further comprising:

a dust removing chamber for isolating the assembly from an outside to thereby remove the dust from said assembly;

an inlet door opened and closed when the assembly is conveyed into said dust removing chamber;

an outlet door opened and closed when the assembly is conveyed out of said dust removing chamber; and

conveying means for conveying the assembly into and then out of said dust removing chamber.

6. A device according to claim 5, further comprising air sucking means for introducing cleaned outside air into said dust removing chamber to thereby

maintain a positive pressure in said dust removing chamber.

7. A device according to any one of claims 2 to 6, wherein said sucking means sucks the dust only during the interval between the consecutive air jets.

8. A device according to anyone of the preceding claims, wherein said air jetting means jets ionized air onto the assembly to thereby electrically neutralize the dust deposited on said assembly, whereby adhesion of said dust to said assembly is weakened.

9. A device according to any one of the preceding claims, further comprising:

a dust removing chamber for isolating the assembly from an outside to thereby remove the dust from said assembly;

an inlet door opened and closed when the assembly is conveyed into said dust removing chamber;

an outlet door opened and closed when the assembly is conveyed out of said dust removing chamber; and

conveying means for conveying the assembly into and then out of said dust removing chamber.

10. A device of removing dust deposited on an assembly, the device being constructed and arranged to operate substantially as hereinbefore described with reference to Figures 2 to 4 of the accompanying drawings.

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Application No: GB 9910936.5 **Examiner:** Paul Gavin
Claims searched: All **Date of search:** 1 July 1999

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.Q): F4X(XA2D)

Int Cl (Ed.6): B08B(5/00,02,04)

Other: Online : WPI, EPODOC, JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB 2 253 271 A	(SEIKO) - Consider especially page 5 lines 11 to 20 & page 6 lines 3 to 8.	All
X	EP 0 183 192 A2	(STERIL) - Consider whole document	1,4,5 & 9, at least
X	US 5 711 821	(TEXAS) - Consider especially col.3 lines 8 to 30 & col.6 line 45 to col.7 line 10.	1 & 4 at least
X	US 4 835 808	(ELTEX-ELEK.) - Consider especially col 2 lines 40 to 43.	1,4 & 8 at least
X	US 3 915 739	(MONTREAL) - Consider whole document.	1,4 & 7 at least
X	JP 7 096 259 A	(ULVAC) - Consider especially attached WPI & JAPIO abstracts.	1,2,4 & 7, at least
X	JP 2 006 886 A	(HITACHI) - Consider especially attached JAPIO abstract.	1,2, & 4, at least
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